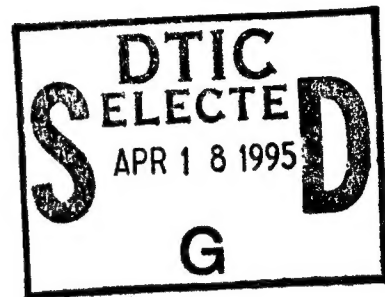NAVAL WAR COLLEGE
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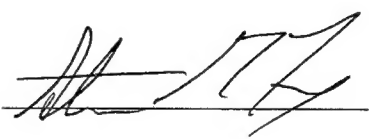
UNINTENDED CONSEQUENCES OF JOINT DIGITIZATION

by

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Major, U.S. Army

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Operations.

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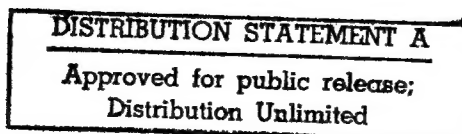
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Abstract of

Unintended Consequences of Joint Digitization

The use of digital technology for future military operations will bring unintended consequences that will profoundly affect the art of warfighting. Joint digitization is an architecture that improves joint C2 functions through the availability of real-time situational information, links between sensors to shooters, and the use of integrated shared knowledge by automatically generating informational data bases. The idea of joint digitization is to enhance the warfighters C2 decision-cycle through a seamless integrated digital information network. Although it is expected technology will continue to bring huge payoffs, military professionals cannot assume that the use of technology by itself will be the panacea to achieving risk-free operations. Arguably, embracing digital technology also can bring accidental consequences that can damage and weaken a military organization. This paper is not about the science of digital technologies, but about the unplanned affects it might have upon the art of war. There are three possible unintended consequences of digital technology: 1) the merging of operational and tactical levels of war; 2) the general diminishing of a commander's prerogatives; and 3) an increase in the fragility of the force.

Introduction

The use of digital technology for future military will bring unintended consequences that will profoundly affect the art of warfighting. Technology has always had a deep effect on organizations that conduct warfare and, in each case, innovations have forever changed the nature of warfare. Although it is expected technology will continue to bring huge payoffs, military professionals cannot assume that the use of technology by itself will be the panacea for achieving risk-free operations. Technology, specifically digitization, promises to reduce the uncertainty and increase a warfighter's lethality; however, applying science to solve problems often leads to unanticipated new problems. Arguably, embracing digital technology can also bring accidental consequences that can damage and weaken military organizations. This paper is not about the science of digital technologies, but about the unplanned affects digitization might have upon the art of war.

Digitization is the application of micro-processors to achieve a seamless information flow for coordinating and employing war fighting assets. This paper addresses Twenty-first century issues assuming that a fully joint interoperable C4I system has been achieved, such as the objective version of Global Command and Control System (GCCS).[1] This paper also assumes that the goals of the Navy's Copernicus and the Army's Digitized Battlefield future architectures are realized and fully interoperable, as well as the intent of the Air Force's Horizon strategy.[2] The essence of this metamorphosis toward "joint digitization" is an architecture that improves joint C2 functions through the availability of near-real-time situational information, the links between sensors to shooters, and the use of integrated shared knowledge by automatically generating informational data bases. It is a digitization of the

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entire joint battle space that processes, displays, and transfers information between echelons horizontally, inter-service, and among allies. The idea is to enhance the warfighters C2 decision-cycle through a seamless integrated digital information network that also supports the warfighter's weapons systems.[3] There are three possible unintended consequences of digital technology that will affect military leaders' approach toward the art of war: 1) the merging of operational and tactical levels of war; 2) the general diminishing of a commander's prerogatives; and 3) an increase in the fragility of the force.

Today, the operational level serves as a link between strategic aims and tactical employment of forces. Digitization unintentionally will have the effect of dismantling hierarchical structures and increasing the importance of the link between strategic and tactical levels. The traditional strategic, operational and tactical levels will gradually mutate into a blurry, flatter two tier hierarchy where the operational and tactical levels merge. It is not clear whether the effects of merging the levels are beneficial or detrimental to a theater of operations.

The second unintended consequence is the trimming back of the traditional boldness and initiative of subordinate leaders. Since the future portends that threats will be less well defined, military missions will have more acute, direct political consequences that will demand a tighter reign on commanders. As a result of mass media coverage, civilian leaders will pressure military leaders for constant updates in order to maintain public support. It is quite possible that the initiative and boldness traditionally expected of American warfighters will be severely constrained by superior's strong oversight. Digitization, meant to give commanders

greater autonomy might actually strip commanders--especially those considered at the tactical level--of their individual prerogatives.

Finally, as our services improve their lethality through digitization, which also results in better situational awareness and quicker reaction times, the fragility of the force might increase. The new lack of robustness due to more complex electronic systems might negatively effect the ability of the force to quickly recover from the rigors of war. Issues concerning replacement of high-tech personnel casualties, availability of complex repair parts and ease at which long haul communications can be disrupted could all contribute dramatically to the future endurance of the joint digitized force.

Merging Levels of War

The American public's lack of stamina to endure a protracted conflict and their abhorrence of battlefield casualties requires quick, decisive, strategic results. It is the warfighters quest for immediate strategic results that will force the restructure of the three levels of war. With the help of information technology, joint commanders of the Twenty-first century will be able to efficiently command and control geometrically greater battle spaces at a far greater tempo and confidence level. The amount of uncertainty will be less. The virtually seamless flow of information from the lowest echelons--conceivably individual battalions, ships or aircraft--gives joint commanders a significantly increased knowledge base from which to coordinate, synchronize, and employ forces. This knowledge will be shared nearly simultaneous throughout the chain of command. The force multiplying effect of shared information will be to achieve a greater coherence and unity of effort with significantly fewer casualties. Consequently, actions at every level will instantaneously effect the other and will

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have the affect of reducing the time between decisions. [4] Furthermore, the trend toward more powerful weapon systems will give rise to tactical elements being employed more often in direct support of strategic objectives. Situational awareness will permit the conduct of simultaneous offensive operations allowing the capability to convert tactical success immediately into decisive strategic results.[5]

In the pursuit of more decisive operations, a great shift in the power to make operational and tactical decisions at one echelon will occur. The desirability of this shift will depend on how senior leaders adapt to the greater responsibility. A goal of joint digitization is to provide a greater assimilation of more information into the warfighting process. This implementation goal will ultimately expand the strategic level's span of control with the streamlining of the operational chain of command. Today, military organizations are generally sized by how much one commander can effectively control. By design, each echelon's commander is better informed to make appropriate decisions concerning his responsibilities. During the late 1980's and early 1990's, an evolution in business management led by the integration of information systems caused an increase in the span of control for a typical senior manager; this subsequently resulted in a flattening of the management structure. Likewise, digitization will provide more senior leaders the information that will permit them to feel comfortable making more judgments that were traditionally left to operational and tactical commanders. As in business, digitization will cause an increase in the span of control at the strategic level and a subsequent greater centralization of command. In the future, digital technology will render our current structure obsolete.

A flatter structure may not be always beneficial. The disadvantage of centralization is the magnitude that each decision potentially has. Mistakes in simple judgment can lead to greater, longer lasting consequences. Since the influence of a strong commander permeates throughout, there may be cases where trusting a single individual's perceptions may be, in the end, very costly in terms of resources, lives, and continued public support.

Another important reason for the merging levels of war is that communication between all echelons is expected to shift dissemination and collection of intelligence, targeting, and other data from hierarchical to a non-hierarchical command structure (See Figure 1.).

Figure 1
Command Information Structures[6]

Hierarchical Structure   Non-Hierarchical Structure
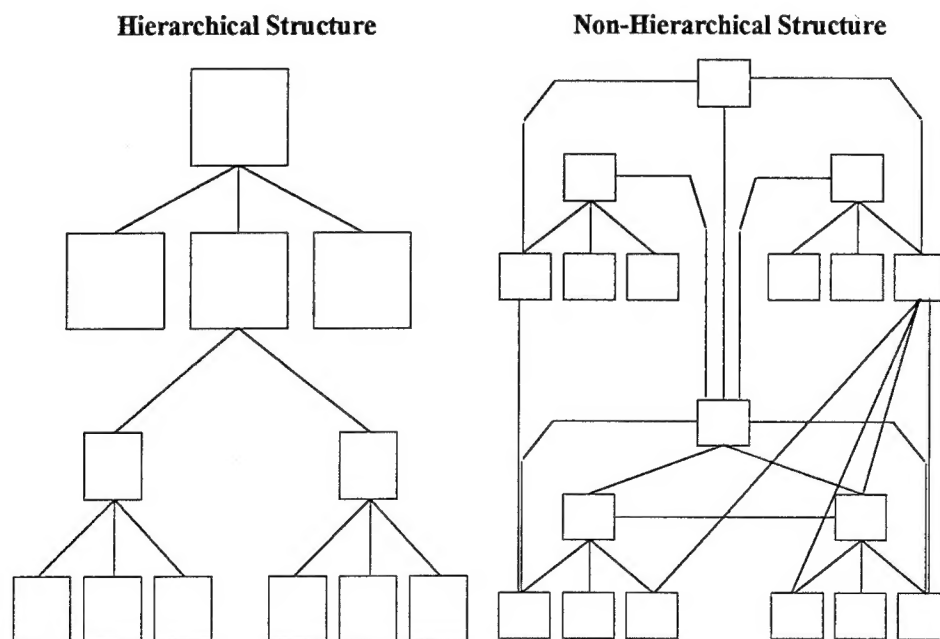
This internetted command structure undesirably leads to an "diffused command authority"[7] Even today there are indications of just how future technology can alter command approaches within the military. Electronic mail (E-mail) has created a formal, as well as, informal

dissemination structure within the Department of Defense. The ease at which an individual can send a courtesy copy or a message to anyone, regardless of position, has placed unusual demands upon an organization's hierarchy. It is easy to interpolate how the future and its promise for "smarter" systems, which are better able to assimilate and display information, can change the traditional needs for hierarchical levels. What is not clear is the effect that these informal lines of communications will have on a command structure during times of conflict.

As technology increases the strategic echelon's span of control, there will be a predictable gravitation to coordinate tactical weapons at the highest possible level; thus, more pressure to flatten or merge the levels of war. Improved war-fighting capabilities which have increased the mobility, dispersion, lethality, and tempo will drive control measures at least to a joint theater level. Centralized control is needed for synchronization of combat power in order to conserve assets, and prevent fratricide and civilian collateral damage. Weapon systems could be enabled or disabled remotely whether they are on a ship, land or aircraft. It will be possible to control tactical fires and the maneuvers of combat elements to optimize the direct obtainment of the strategic goal. These combat elements will be armed with far more sophisticated direct and indirect munitions with ranges that exceed line of sight. Military professionals saw just a glimpse of technology during Desert Storm. By Twenty-first century standards, Desert Storm will look antiquated, but it illustrates just how complex and how important synchronizing forces are in order to prevent friendly casualties and to insure decisive strategic results.

The significance for future military organizations is that traditional tactical and operational levels will have the same information and same battle space concerns. The need

for separation based upon capability to command and control will likely cease to exist in the

Twenty-first century. The overall disadvantages of this merging has yet to form. How the

senior leadership adapts and structures the resulting organizations will determine the

magnitude of the drawbacks.

Diminished Command Prerogatives

Like many problems, the solutions often have undesirable consequences. It is quite

possible that digitization upon Twenty-first century military organization will be detrimental to

the concept of execution at the lowest level and could lead to over control. With the shared

vision resulting from digitization, every one within the chain of command could have access to

the same situational information. Theoretically, everyone from the White House, the Joint

Staff and CINC Staffs, down to the tactical levels could have access to the same facts.

Potentially it could become normal for some operational and tactical level decisions to come

from the White House or the Joint Staff. The United States military requires leaders that

possess boldness and initiative to act on one's own judgment. These traits within our leaders

make the U.S. military a formidable force. Digitization may unintentionally affect the

relationship between echelons by limiting the organization's initiative, ingenuity, and

inventiveness through constant monitoring by superiors.

No one likes to have someone looking over their shoulder as they work. Increased

theater awareness and the ability to automatically transfer databases will result in the

expansion and availability of on-line information. This may very likely result in a great deal of

second guessing by senior commanders and staff. Invariably during a crisis, a subordinate

commander who is closer to the action will select a different course of action than that of the

senior commander. Should the superior commander second guess and redirect the effort or sit on his hands and wait it out? The challenge for senior leaders in the future will be curtailing their inclinations and allowing subordinate leaders their prerogatives. When a commander thinks he has all the facts, allowing a subordinate his prerogatives by not interfering goes against the "zero defects" culture that permeates the military today; unfortunately, there is no evidence that the future culture will be any different.

Information technology will also find it hard to digitize what is in the commander's head and what he feels--the kind of intangible awareness that comes from being close and near the area of operation. Our forces will fight the way they train. There is a danger that factors that cannot be quantified will be disregarded and our commanders not near the action will be "partly conditioned" by the technical tools available to them.[8] For example, during a peacetime exercise, based on intuition or other undigitizable information, a commander may want to deviate from a plan during its execution. How many times will a commander accept corrections or challenges, by a "all-knowing" higher commander or superior's staff. Echelons above may believe they understand and have the "correct" bigger picture and demand adherence to previously coordinated plans or only minor tweaks to an existing plan. There are very few commanders, believing they have the right situational information, that can allow a subordinate to act contrary or independently to their expectations without at least making an inquiry. Sure, the subordinate commander could explain and defend his actions and even prevail; however, a sense of autonomy, pride and creativeness is predictably lost by a subordinate each time it occurs. It doesn't take many real-time corrections or constant challenges by a boss to stifle boldness and initiative. It might be hard for today's leaders to

appreciate the loss of initiative and boldness caused by digitization, since they have had these traits nurtured into them throughout their careers. The concern should be about the generation of leaders who grow up with extensive and perhaps constant oversight and monitoring.

The Marines "Warfighting" manual, FMFM 1, has recognized this concern and has succinctly stated, "Equipment that permits over control of units in battle is in conflict with the Marine Corps's philosophy of command and is not justifiable."[9] The digitization technology of the Twenty-first century, by obtaining massive situational awareness, may have the unintended consequence of permitting commanders too much control. The military services could be entering into a new era of electronic micro-managing.

The pressure to micro-manage, to ask questions, and to second guess field commander's decisions will be very high. Consider a CINC or a Joint Task Force commander, with the military and civilian leadership in Washington D.C. and the media doggedly pursuing in "real time" their individual stories, demanding to know status and planned intentions. The pressures will be enormous for information. With instantaneous civilian global information networks, such as CNN and broadcast network news, our civilian population has become more addicted to war news.[10] For the future, the "CNN war leads public and leaders to define political events in terms of the video clips and sound bites that compose TV news images."[11] A causal effect of this coverage is that the available reaction time to events for civilian policy makers is going to decrease because of amplified public interest.[12] The American people are going to demand more information from their senior

civilian and military leaders. Accordingly, policy makers are going to want to know more and want to know it sooner.

The pressure upon senior military leaders to supply only the most accurate information and not to publicly embarrass themselves, as well as their civilian leaders will be immense. The future joint leader and corresponding staff are going to be forced to make larger number of inquires to satisfy the media and public. Situational awareness through digital technology will be the enabling technology for maintaining public support for the military, as well as keeping the political leadership from embarrassment.

A good counter argument might be that unintrusive electronic queries will be extensively used and the distraction will be very minor. This argument holds well, if the question is strictly qualitative in nature, is an acceptable answer, or doesn't require explanations. Unfortunately, it is more likely that one answer will precipitate several more questions that may or may not be available unobtrusively through a electronic data base. Digitization might inadvertently and unanticipatedly increase outside distractions through the answering of endless questions up the chain of command. On the positive side, it is easy to see how this kind of uncontrolled eavesdropping by a higher level staff can lead to better situational awareness and better serve a joint commander. Sadly, it is hard to imagine how unencumbered, direct access to planning and execution information by a superior and his staff, without the subordinate's personal spin, could have a positive effect on the hard-charging, self-motivated commander.

One could argue that the higher echelons will not be interested in information that is specific and in detail. It is more likely that the smaller Twenty-first century force structure will limit the options available to our senior leaders. Consequently, leaders will require more

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specific information in order to make decisions. For example, the Joint Staff is currently in the process of developing and fielding the first phase of the Global Command and Control System (GCCS). ADM Owens, Vice Chairman, Joint Chief of Staff was given a demonstration of the Global Status of Resources and Training System (GSORTS). While being impressed with its capability to easily understand air base and other readiness ratings he indicated it would be nice to also receive the aircraft availability by individual weapon's load, including Precision Guided Munitions (PGMs), and by sensors in a particular area of responsibility.[13] What is significant is not that the Admiral wanted to know this information, but how the information is going to be used at the strategic level. What if the information is not as expected or quantifiably correct? Very few leaders like to be surprised, and with the relatively smaller force structure, specifics are becoming very important.

Another concern is whether our warfighters will be prepared for the avalanche of questions. It cannot be discounted that routine questions from higher echelons tend to increase exponentially in importance the farther down the chain of command they propagate. So the lower echeloned, smaller staffed, war-fighting organizations are less prepared to handle queries and are distracted disproportionately.

Often in discussions about digitization and automation, it is surmised that staff sizes will decrease in numbers.[14] It is quite possible that staff sizes may need to increase--not decrease. The requirement for information is compounded by the problem that during peace there is a tendency to become over organized and more bureaucratic in structure.[15] This tendency can be summarized as the "need-to-know everything" syndrome. The propensity to explain and track data is gradually taking up more of the commander's and staff's time. As

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our services become more complex, more records and information are required to be processed and the demand for support staff increases. Large bureaucratic staffs do not normally foster and facilitate initiative and boldness in subordinate organizations.

The military has already experienced the unintended consequences of automation when it comes to bureaucratic staff work. Consider how the word processor has streamlined typing and the electronic mailing of documents and messages. As stated before, automated offices are able to effortlessly and with efficiency send documents and E-mail via Local Area Networks and, through MILNET, between organizations. These tools obviously save time through simplifying distribution, increasing information transfers between organizations, thereby decreasing the number of secretaries and military clerks. However, the demand for more usable information by senior decision makers has also increased, requiring staff officers to spend greater portions of their time typing questions and answers. With the increase in productivity, automation has fostered an increase in reporting and information generation. It is true that reports and briefs are now written easily on computers, but organizations tend now to spend more time reworking letters and briefing charts to achieve limited gains in redrafts and minor formatting. The reworking does not necessarily result in better content but only ensures cosmetically perfect documents. The labor saving and time saving office computer has the unintended consequence of creating more work. Computers have increased the military staffs work load and have unintentionally required more staff, not less.

Increased Fragility

General Sullivan, Chief of Staff, Army, states technology driven battle space awareness "can provide us with lighter, more effective and more lethal weapon systems to

offset our smaller force structure."[16] But, one also must consider that as these force multiplying systems are effected by attritions of war, their corresponding impact upon the force is an equally multiplying loss. Digital technologies provide a tremendous capability, however, they must be weighted cautiously against their vulnerabilities.

The use of digital technology has consequences that are paradoxical in nature. While it is true that the implementation of more advanced sensor-to-weapon systems will give better situational awareness, help minimize fratricide and better focus combat power, they can also be our Achilles heel. There is the concern whether the new electronic systems will have the resilience to absorb shocks and withstand perturbations associated with the realities of modern war. The more advanced the equipment the more complex it becomes. The more complex the system, the less reliable, and the harder or longer it takes to repair.

A possible solution to the attrition issue is the use of redundancy in the digital architecture. Redundancy is not likely to protect the force as technology is being looked upon by our senior leaders to help mitigate the smaller force structure. It is a reality that the U.S. military will always be dependent upon finite amounts of specialized electronic equipment that will invariably not be easily replaced nor repaired.

There are other compounding effects of attrition, such as the digital technologies dependence upon reliable communication architectures. It is the dependence and reliance of electronically synthesized data from widely dispersed systems that makes communications the most vulnerable segment. The greatest threat to the entire digitization architecture is the lack of robust, redundant communications paths. For example, Desert Storm validated the notion that a CONUS based force projection strategy, with its anticipated tempo is dependent upon

assured satellite communications for both inter- and intra-theater communications irrespective of use on land or sea. Above the tactical level of war, it is anticipated for the Twenty-first century that medium data rates for the military, as well as civilian satellite systems, will be vulnerable to jamming by today's low cost technology.[17] Since digital communications demands are going to be predictably greater than their capacity, there will be no redundancy nor unused capacity.[18] Even today it is doctrine not to normally keep communication equipment in reserve. Also, key communications equipment is subject to targeting through old-fashioned direct or indirect fires. An unsophisticated enemy sharp-shooter could easily fire a well placed bullet and take out the feed to a critical satellite or a microwave antenna.[19] This would effectively disrupt the digital architecture with devastating consequences to the command and control process. Communications will be the weakest link for the future's dispersed digitized systems.

There is a trend growing within the U.S. military to use commercially available off-the-shelf technology that is generally not designed to Military Standards nor for ease of trouble shooting. An unintentional result of using the less rugged commercial electronic equipment is it will require warfighting organizations to have near-by repairmen and large stocks within theater of specialized electronic repair parts. Otherwise, replenishment could become a problem since strategic mobility will always be at a premium during a crisis.

Repair parts may not always be available. A CONUS based support structure assumes that the tempo at which critical items are used and destroyed will not exceed the rate at which they are being replaced. If tradition holds, then the military will keep electronic equipment beyond normal commercial applications. CONUS depots will have to have on-hand the repair

parts since industry does not normally keep the production lines of specialized nor dated electronic designs operating. Leaders will need to take into account and understand the perishability and limited availability of electronic equipment.

Lack of timely repair could contribute to the increased fragility of the force. The advanced equipment of the future, whether it be built to commercial or military standards, will require a greater level of maintenance expertise. The philosophy of using built-in diagnostic and automatic check-out equipment does design complexity away from the operator; however, repair responsibilities dramatically shift to maintenance personnel.[20] Repairing systems in the forward areas will be more difficult and there will be a greater tendency to evacuate equipment for repairs to the depots; thus increasing the time to repair.[21] Based on complexity, it can be anticipated that digital electronic systems are going to have a much longer logistics tail than we have today.

Our force structure will likely have a critical shortage of qualified electronic technicians. Consider the same scenario of equipment damaged by a "low-tech" sharpshooter. What if the shooter decides to wait around to kill the skilled operator or maintenance person conducting the repair?[22] Skilled repairmen will not be replaced easily. Maintenance personnel of the future will require more extensive and sophisticated training than today's technicians, since the systems will be more intricate. As the armed forces continue to compete against educational institutions and private corporations for the limited number of qualified 17-24 year-olds, it is going to be a challenge to keep qualified personnel skilled in electronics. Even the reliance on dedicated and first-rate National Guard and Reserve units is optimistic. Units meant to augment during national emergencies may not be able to keep operator and repair

personnel up to warfighting standards. The implication--"there will be time for training after the troops are assembled--is virtually over."[23] It is not quantitatively known whether the rate of replacement of critical specialty skills will not be able to keep pace, but one only has to look at where we are traditionally short of technical specialists today. Like during Desert Storm, due to the maintenance complexity of electronic equipment and the lack of qualified military personnel, it will be common for the Services to depend upon civilian technicians in forward deployed areas for maintenance and repair. It is possible that demographics, and sociopolitical educational realities, might just be the limiting factors of the Twenty-first century digitized force. The demand for "high-tech" personnel is going to go up--not down.

Another concern for the future is that we will depend more upon our allies for support. As the United States modernizes its forces with the latest electronic gadgetry, will our allies be willing to invest in the same kinds of equipment, or will we be willing to sell or give it to them? By digitizing everything from Command and Control to weapons systems, they might make it impossible to be electronically interoperable within a theater with our coalition partners.

Challenge of the Future

It is obvious that embracing digital technology offers a great deal to the warfighter. If the equipment envisioned for the future is developed and fully realized, the enhancement to Command and Control will dramatically streamline operations. For the future, technology will permit greater situational awareness that reduces the commander's uncertainty and anxiety. It will certainly increase the warfighter's lethality through the ability to better focus and synchronize combat power. The unintended consequences of this solution will be a challenge

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for future military leaders to understand. Leaders need to understand the impact upon the operational art of war that technology brings.

Digital technology allows many advantages, but it is not without its soft intangible price. The possibility that the very strength that digital technology brings, situational awareness, may be the cause for trimming a commander's prerogatives. This trimming undermines the very concept of individual initiative that makes the U.S. military such a formidable force. Another soft cost is that complex equipment may be so intricate as to require skills and resources that are not easily replaced during the conduct of war.

The U.S. Military needs to adapt to new technology or it faces the prospect of allowing itself to grow flaccid and obsolete. The issues raised in this paper have no direct solution. Yet, a great deal of the problems highlighted, especially in the area of commander's prerogatives, is dependent upon how the senior leadership grows to use the technology and how they guide the emerging organizational culture to use it. Awareness of the strengths, and more importantly, weaknesses that technology brings to an organization must be the precursor to its implementation. Caution and reflection might be in order to insure that a particular solution's negative ramifications are well understood and its advantages are absolute. It is safe to predict that joint digitization and all its capabilities that it brings will be beneficial. It would be unfortunate, however, that in the process of fixing today's problems a whole new array of unanticipated consequences arise without a plan to discern nor understand them. Developing a clear plan is the challenge for the future.

[1] Gen John M. Shalikashvili, "Letter of Introduction," C4I for the Warrior: Global Command & Control System, from Concept to Reality, (Washington: J6 Joint Staff, The Pentagon, 12 June 1994). The GCCS objective is to provide "total battle space information to the warrior."

[2] Ibid., "Proofs of Concepts."

[3] Christopher V. Cardine, "Digitization of the Battlefield," Unpublished Research Paper, U.S. Army War College, Carlisle Barracks, PA: 1994, p. 9.

[4] Douglas A. MacGregor, "Future Battle: The Merging Levels of War," Parameters, Winter 1992-93, p. 41.

[5] Ibid., p. 33.

[6] U.S. Department of the Army, Force XXI Operations: A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty-First Century, Fort Monroe, VA: Army Training and Doctrine Command, 1 August 1994, p. 2-9.

[7] U.S. Department of the Army, Force XXI Operations: A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty-First Century, Fort Monroe, VA: Army Training and Doctrine Command, 1 August 1994, p. 2-8.

[8] Martin Van Creveld, Technology and War: from 2000 BC to the Present, 2nd ed. (New York: The Free Press, A Division of Macmillian, 1991), p. 247.

[9] U.S. Marine Corps, Warfighting, FMFM 1, Washington: U.S. Marine Corps, 1989, p. 52.

[10] Antulio J. Echevarria and other, "The New Military Revolution: Post-Industrial Change," Parameters, Winter 1992-93, p. 77.

[11] Frank J. Stech, "Winning CNN Wars," Parameters, Autumn 1994, p. 39.

[12] Echevarria, p. 77.

[13] Telephone conversation with LtCol Basla, The Joint Chiefs of Staff (J6V), Washington, DC, 27 January 1995.

[14] Cardine, p. 23.

[15] Van Creveld, p. 236.

[16] Gordon R. Sullivan, "Moving into the 21st Century: America's Army and Modernization," Military Review, July 1993, p. 6.

[17] Medium data rates are considered above 2.4kbs to 1.544Mbs. The Milstar and UFO-follow-on satellite systems have EHF anti-jam systems that will provide the tactical & strategic commanders with assured communications. However, part of Milstar is designed specifically for the tactical commander and is the only satellite that can provide EHF anti-jam medium data rates above 2.4kbps up through to 1.544Mbs (T1-rate). Other systems such as DSCS and the UHF systems cannot assure large anti-jam capacities at the anticipated loading. It should be noted that DSCS is capable of high data rates in a benign, non-jamming environment.

[18] Telephone Conversation with LTC Primo, The Joint Chiefs of Staff (J6S), Washington, DC, 25 January 1995. According to LTC Primo, demand will continue to exceed capacity; satellite data requirements are growing exponentially. The total future data rates identified to date are approximately 5Gbs in comparison to today's satellite capacity potential of 1.5Gbs. It should be noted that potential satellite capacity assumes perfect and optimum link closures using large strategic dishes (60'). The use of tactical or disadvantaged smaller dishes has not been taken into account and would reduce the figure significantly.

[19] Julie Ryan and et al., Information Support to Military Operations in the Year 2000 and Beyond: Security Implications, (Alexandria, VA: Center for Naval Analyses, November 1993), p. 11.

[20] Martin Binkin, Military Technology and Defense Manpower, (Washington: The Brookings Institution, 1986) p.58.

[21] An example of shipping complex electronic equipment back to the depot for repair is the Precise, Lightweight GPS Receiver (PLGR). Units are shipped back to the manufacturer under a military procured warranty program. No repairs are attempted in the field. This method does insure first class repair, but it temporarily removes the receiver out of the hands of the user unless a logistics "float" is available within the unit.

[22] Ryan, et al., p.11.

[23] Echevarria, p. 76.

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